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New records of the genus *Whartonia* (Acari, Leeuwenhoekiidae) associated with the bat *Carollia perspicillata* from southeastern Brazil

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Abstract: Two species of mites belonging to the genus *Whartonia* Ewing, 1944, family Leeuwenhoekiidae (Womersley, 1944), were obtained from *Carollia perspicillata* (Linnaeus, 1758) bats from mine tunnels in the municipalities of São José da Safira and Medina, Brazil: *W.* (*W*). *pachywhartoni* Vercammen-Grandjean, 1966 and *W.* (*W.*) *nudosetosa* Wharton, 1938. A table with all *Whartonia (Whartonia)* species and their respective morphological characters is presented.

Key words: Neotropical region, Parasitengona, Chiroptera, chigger, Trombiculoidea

The genus *Whartonia* Ewing, 1944 comprises 40 species of mites widely distributed throughout tropical and subtropical regions of the world and are usually associated with bats (Takahashi et al. 2006). Despite its diversified chiropteran fauna and a suitable climate, only a single species of the genus was recorded in Brazil, *W.* (*W.*) *pachywhartoni* Vercammen-Grandjean, 1966. Along with a new occurrence of this species, for which type material was lost, we report the occurrence of *W.* (*W.*) *nudosetosa* Wharton, 1938. Occurrences of both species are summarized in Figure 1.

Specimens were obtained during an inventory of the vertebrate fauna from mine tunnels at localities in Minas Gerais state, southeastern Brazil (Teixeira and Ferreira 2010). Individuals of *Carollia perspicillata* (Linnaeus, 1758) were obtained using mist nets fastened to the walls of the conduit with the aid of metal shafts and hand nets for capturing bats within reach.

Individuals reported here were collected in bats living inside a tunnel in the "Chiá" region, 770 m above sea level, 14 July 2008 in the municipality of São José da Safira (18°19′26″ S , 042°08′34″ W) and in a tunnel in the "Fazenda Terra do Sol" (15 July 2008), in the municipality of Medina (16°13′21″ S, 041°28′36″ W). Mites were removed from bats with the aid of fine-tipped tweezers and brushes soaked in alcohol and fixed in 70% ethanol in containers individualized by host.

The material was studied as slide-mounted specimens. For this purpose, specimens were cleared in Nesbitt's solution and mounted on slides using Hoyer's medium for microscopy studies (Krantz and Walter 2009). Specimens were studied and measured using a Zeiss Primo Star microscope, connected to a Zeiss AxioCam ERc5s camera, through the Carl Zeiss ZEN 2012 SP1 Lite Blue Edition image acquiring software, and presented in micrometers (μm) as a range. Terminology used in the present descriptions was defined by Goff et al. (1982).

Specimens are deposited at the Acarological Collection (UFMG-AC), Universidade Federal de Minas Gerais, Minas Gerais, Brazil and additional material were deposited at Collection of Subterranean Invertebrates (ISLA), Section of Zoology, Department of Biology, Universidade Federal de Lavras, Lavras-MG, Brazil. Additional specimens from Ohio State University Acarological Collection (OSAL) and from the Field Museum, Chicago, were also examined.

Whartonia (Whartonia) pachywhartoni Vercammen-Grandjean, 1966

Whartonia pachywhartoni Vercammen-Grandjean 1966: 282. Takahashi, Takahashi and Kikushi 2006: 132.

Diagnosis. Palpal setal formula (fPp) B/B/BBB/7B; palpal claws six-pronged; galeal seta branched; synthetic identification formula (SIF) 7B-B-6-2-1-1-1-000; scutum rectangular with small punctations, more than four times wider than long. Sensillae nude; scutal setae stiff and covered by barbulae; anteromedial setae (AM) longer than posteromedial setae (PL); PL longer than

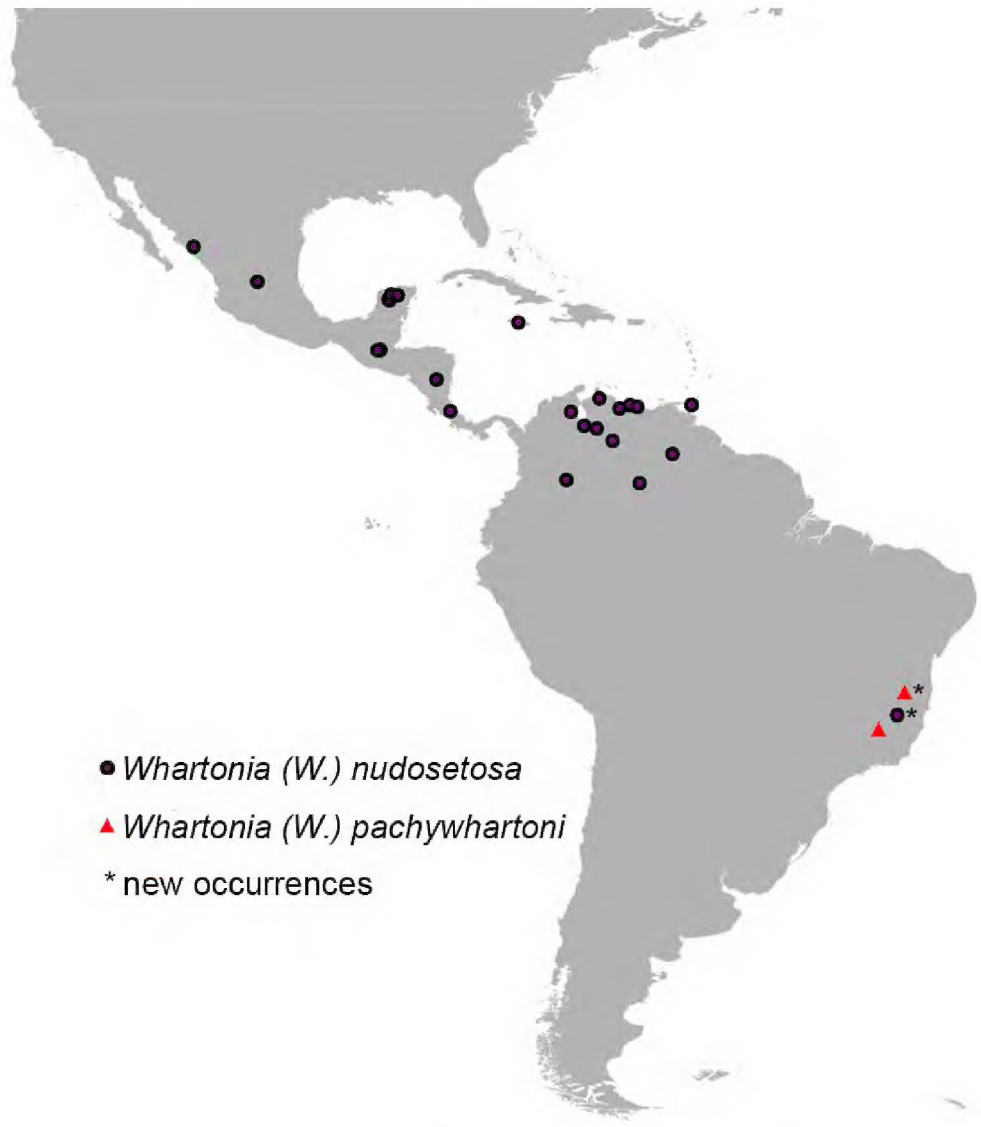

Figure 1. Americas map displaying records of *Whartonia (Whartonia) pachywhartoni* Vercammen-Grandjean, 1966 (triangles) and *Whartonia (Whartonia) nudosetosa* Wharton, 1938 (circles). Most of localities are approximate, according to references listed in the synonymic lists presented in this study.

anterolateral setae (AL); genualae on legs following the formulae 2,1,1; tibialae on legs 2,2,1; in the leg setae tabulations (LST), the number of femoral branched setae on each of the legs I, II, III is 6,5,4; solenidion on tarsi III; cheliceral blade with minute saw-like edges on dorsal and ventral surfaces; dorsal body setae 52–64 in number. Number of ventral and postanal setae 59–84, including a pair of sternal setae; total number of idiosomal setae (NDV), excluding coxal setae, 111–148; leg index 1263–1342 µm.

Description. Larvae (UFMG-AC1200082-1): In the description, measurements and numbers presented by Vercammen-Grandjean (1966) are between parentheses. Specimen not engorged**.** Body longer than wide. Idiosoma 250 µm long, 232 µm wide.

Gnathosoma. Cheliceral bases rounded with small punctuations; movable digit of chelicera 88 µm long, with saw-like edges on dorsal and ventral surface; palp elongate; palp femura with lateral triangular processes; palp setal formula (fPp) B/B/BBB/7B; gnathosomal base with small light punctations and a pair of slender, short barbed setae. Palp claw stout, six-pronged, axial prong 35 µm long, among other prongs, three of similar size, almost half of axial prong length; galeal seta branched.

Scutum. AM at almost same level as AL setae. Sensillary bases slightly posterior to level of PL setae bases. AM>PL>AL. Sensillae unexpanded, nude, flagelliform. Other scutal setae stiff and covered by barbualae. Scutal measurements: AW, 133 (123); PW, 140 (134); SB, 52 (54); ASB, 55 (46); PSB, 11(8); AP, 29(24); AM, 90 (83); AL, 59–55(57); and PL 86(79). The distance between setae AM and the slightly raised mid-anterior portion 11 (14) µm and the distance between paired AM setae is 13 (14) µm.

Idiosomal setae. One pair humeral setae (HS) measuring 58–82 (74) µm long; 52 (64) idiosomal dorsal setae (DS) arranged in irregular rows; DS covered with short setules for their entire length, length of DS, 58–70 µm. Pair of sternal setae present, 49 µm long; 39 preanal setae (or true ventral setae) (VS) similar to sternal setae in nature but shorter; 18 postanal setae; length of ventral setae: 35–45 µm long; NDV= 57+52=109 (64+84=148).

Legs. *Index pedibus* IP = 1499 (1347) µm. All legs six-segmented, terminating in a pair of claws and a slender claw-like empodium. Onychotriches absent. Conspicuous small punctations on coxae. Coxa I with conspicuous process pointing outward.

Leg I. 503 (449) µm long; tarsus I 69 µm long, 21 µm wide; coxae with two non-specialized setae with short setules (2B); trochanter 1B; femur 6B; genu 4B, 2 genualae (proximal genuala 39 µm, dorsal genuala 36 µm); tibia 8B, two tibialae (proximal tibiala 26 µm, distal tibiala 26 µm), microtibiala 13 µm; tarsus 50B, tarsala 26 µm, microtarsala 5 µm, parasubterminala 22 µm, subterminala 27 µm, pretarsala 15 µm.

Leg II. 480 (469) µm long; tarsus 231 µm long, 252 µm wide; coxa 1B; trochanter 1B; femur 5B; genu 4B, genuala 57 µm , microgenuala 11 µm tibia 5B, two tibialae (proximal tibiala 19 µm, distal tibiala 24 µm); tarsus 44B, tarsala 24 µm, pretarsala 15 µm.

Leg III. 516 (424) µm long; tarsus 200 µm long by 20 µm wide; coxa 2B; trochanter 1B; femur 4B; genu 4B, genuala 65 µm; tibia 5B, tibiala 50 µm ; tarsus 41B, tarsala 26 µm.

Material Examined. Larva UFMG-AC 1200082-1, on *Carollia perspicillata* (Linnaeus, 1758) at the "Chiá" tunnel (18°17′46.12812″ S, 042°10′57.95832″ W), 14 July 2008, São José da Safira municipality, Minas Gerais state, Brazil. Collector: A. L. M. Teixeira.

The individual described here matches the original description of *Whartonia pachywhartoni* Vercammen-Grandjean, 1966 except for the number of idiosomal setae and minor differences in measurements. It is, however, usual that conspecific chigger individuals exhibit some variation in idiosomal setae counting, indeed with values intervals similar to those observed here (e.g., *Whartonia angulascuta* Reed & Brennam, 1975, and *Euschongastia pipistrelli* Brennan, 1947).

According to the original description, the holotype of *W. pachywhartoni* was obtained from individuals of *Micronycteris megalotis* (Gray, 1842) deposited in the Harvard Museum of Comparative Zoology

(MCZ) collections (catalog numbers 4265, 4671, 4672), collected at "Lagoa Ltd., Brazil" by Mr. G. Sceva, 10 April 1962 and deposited at the Smithsonian Institution, Washington, D.C. (USMN), under the number 10462/6. Reed and Brennan (1975), however, could not found the specimen when preparing their revision on Neotropical Leeuwenhoekidae and inferred that it was possibly misplaced when the USNM chigger collection was moved to the Rocky Mountain Laboratory. There are no references to this type material in recent accounts in USNM collection articles (e.g. Goff 1989), and no mention of it by curators of the USNM collection or the Bishop Museum, where most chigger material was housed. Hence, we consider the type material lost, which makes the specimen reported here useful for future comparisons.

In addition to the holotype being lost, the collection data reported with the original description is wrong. According to data available in MCZbase (2014), *Micronycteris megalotis* individuals collection site is not "Lagoa Ltd." but Lagoa Santa, a municipality in the Minas Gerais state, Brazil. Also, G. Sceva did not collect the bats (and their mites) on 10 April 1962. Even though there is no accurate record of the collection date in the Museum of Comparative Zoology records, the material was handled by the curator on 8 August 1866, almost a century before that indicated by Vercammen-Grandjean (1968). It is beyond doubt that G. Sceva is an abbreviation for George Sceva, one of the members of the Thayer Expedition, which occurred in the years of 1865 and 1866, and had visited the Lagoa Santa municipality and its caves.

Whartonia (Whartonia) nudosetosa (Wharton, 1938)

Hannemania nudosetosa: Wharton 1938: 142; Hoffman 1944: 56; Vercammen-Grandjean 1968: 126. *Whartonia nudosetosa*: Ewing 1944: 102; Hoffman 1949: 189; Wharton and Fuller 1952: 104; Brennan and Jones 1959: 11; Chen and Hsu 1959: 555; Brennan and Dalmat 1960: 185; Hoffman 1960:4; Vercammen-Grandjean 1968:126; Reed and Brennan 1975: 34-35; Webb and Loomis 1977: 66-68, 96; Hoffman 1990: 224; Takahashi, Takahashi and Kikuchi 2006: 131.

Diagnosis. Palpal setal formula (fPp) B/N/B(N or B)(N or B)/7B; palpal claws five-pronged; galeal setae nude or sparsely branched; synthetic identification formula (SIF) 7B-N/B-5-2-1-1-1-000; scutum rectangular with small punctations, more than four times wider than long; sensillae flagelliform; scutal setae stiff and almost smooth, with minute barbulae; AM>PL>AL; genualae on legs following the formulae 2,1,1; tibialae on legs 2,2,1; cheliceral blade with minute saw-like edges on dorsal and ventral surfaces; 30–36 dorsal body setae; 54–62 ventral and postanal setae, including a pair of sternal setae; 90–98 idiosomal setae (NDV) coxal setae excluded; leg index 1081–1325 µm.

Description. Larvae (UFMG-AC1200083-1, 1200083-2, 1200083-3, UFMG-AC 1200329-1200334)

Body longer than wide. Larvae in various states of engorgement. Measurements from newly collected presented along the holotype and comparative material, respectively, between parentheses. Idiosoma 421–648 (710, 514–1143) µm long, 385–772 (620, 435–1118) µm wide.

Gnathosoma. Cheliceral bases rounded with small punctuations; movable digit of chelicera 73–86 (87, 75–85) µm long, with saw-like edges on dorsal and ventral surface; palp elongate; palp femura cylindrical in outline; palpal setal formula (fPp), B/N/BNN-7B, varying in one of the specimens collected in Minas Gerais state (specimen number UFMG-AC1200331), since it has a sparse pectination (only two barbulae) on the lateral setae of the tibia; gnathosomal base with small light punctations and a pair of slender branched setae. Palp claw stout, five-pronged, axial prong 22–24 µm long; galeal setae nude in most specimens, but sparsely branched in some of them (UFMG-AC-1200329, 1200330 and 1300334).

Scutum. AM at almost same level as AL. Sensillary bases slightly posterior to level of PL bases; AM>PL>AL; sensillae nude (unbroken in two specimens). Other scutal setae stiff and varying from almost nude to covered by barbulae. Small punctations distributed on scutum excluding the area around paired AM setae. Scutal measurements (in micrometers): AW, 115–138 (138, 121–131); PW, 127–150 (148, 131–140); SB, 46–59 (50, 46–52); ASB, 38–55 (41, 37–52); PSB, 7–11 (10, 7–7); AP, 24–36 (22, no data); AM, 71–90 (89, 60–84); AL, 54–63 (58, 54–73); and PL, 54–72 (67,65–74). The distance between setae AM and mid-anterior slightly raised portion 8–14 µm and the distance between paired AM setae 9–16 (13, no data) µm.

Idiosomal Setae. Humeral setae (HS) measuring 61–75 (62, no data) µm long; 28–32 idiosomal dorsal setae (DS), 50–83 (40–50, 49–67) µm long, arranged in regular rows; dorsal setae apparently nude but with very short barbulae, which are barely visible, even under oil immersion objectives, but are present along their entire length. Pair of sternal setae measuring 46–54 µm long. 36–40 (30–34, 21–38) preanal setae (or true ventral setae, VS) 25–44 (30–40, 19–38) µm; 20–22 (16, 28–48) postanal setae 28–61 µm. Total number of ventral setae 54–62. NDV= 90–98.

Legs. *Index pedibus* IP 1192–1325 (1075, 1081–1395) µm. All six-segmented, terminating in a pair of claws and a slender claw-like empodium. Onychotriches absent. Conspicuous small punctations on coxae. Coxae I with conspicuous process pointing outward.

Leg I. 381–489 µm long; coxa with two non-specialized pectinate setae (4B); trochanter 1B; femur 6B; genu 4B, 2 genualae (proximal genuala 19–38 µm , dorsal genuala 21–31 µm), microgenualae 9–13 µm; tibia 8B, two tibialae (proximal tibiala 16–28 µm, distal tibiala 20–29 µm),

microtibiala 6–13 µm; tarsus 50B, tarsala 22–27 µm , microtarsala 4–8 µm, parasubterminala 22–31 µm, subterminala 21–31 µm, pretarsala 16–25 µm.

Leg II. 332–426 µm long; coxa 1B; trochanter 1B; femur 5B; genu 4B, genuala 28–40 µm, microgenuala 9–13 µm; tibia 6B, two tibialae (proximal tibiala 13–18 µm, distal tibiala 18–29 µm); tarsus 24B, tarsala 18–27 µm; microtarsala 4–9 µm; pretarsala 15–24 µm.

Leg III. 367–478 µm long; coxa 2B; trochanter 1B; femur 4B; genu 4B, genuala 24–49 µm; tibia 6B, tibiala 15–28 µm; tarsus 23B, tarsala 21–25 µm.

Material Examined. Three larvae, UFMG-AC 1200083-1, 1200083-2, 1200083-3, on *Carollia perspicillata* Linnaeus, 1758 at the artificial tunnel in the "Fazenda Terra do Sol" (16°20′39.40188″ S, 041°27′02.24784″ W), 15 July 2008, Medina municipality, Minas Gerais state, Brazil. Collector: A. Teixeira. Five larvae, UFMG-AC 1200329-1200334, on *Carollia perspicillata* Linnaeus, 1758 at the artificial tunnel in the "Chiá" region (18°19′26″ S, 048°08′34″ W), 15 June 2008, São José da Safira municipality, Minas Gerais state, Brazil. Collector: A. L. M. Teixeira.

Comparative material examined: Two larvae from Ohio State Acarological Collection, codes OSAL98023 and OSAL98024, on *Carollia perspicillata*, Tamana cave, Trinidad, 9 January 1954. Four larvae, from the Field Museum, Chicago: slides code 0-1222 0-1223 ltf, 05 April 1963; 0-1775 1782, 05 July 1963; jkj 4291 wtw, 06 April 1967; jds 3288 vpz, 15 July 1968, from Nicaragua.

Whartonia (*W.*) *nudosetosa* has a complicated history of occurrences, summarized in Figure 1. Wharton (1938) first described it as *Hannemania nudosetosa*. Ewing (1944) proposed a new genus, *Whartonia*, assigning *Hannemania nudosetosa* as its type. Hoffman (1949) added an occurrence record for *W. nudosetosa*, although she observed that the specimens had the setae covered with barbulae, instead of being nude as described by Wharton (1938). Later, Reed and Brennan (1975) redescribed the species from its holotype, confirming the opinion of Hoffman (1949) and adding some new records over Central America. Their description, in addition to the short barbulae on the setae, shows that the holotype of *W. (W.) nudosetosa* departs from its original description by its palpal chaetotatxy, B/B/BBB instead of B/B/BNN, the condition now observed in most of Brazilian material. Apparently the palptibia chaetotaxy is not a reliable diagnostic character for the species.

The subgenus *Whartonia* (*Whartonia*) was erected by Vercammen-Grandjean et al. (1973) without employing phylogenetic methodologies. It is defined as bearing 6, 5, 4 setae on femurs I–III and a solenidion on the posterior tarsus (S3). Takahashi et al. (2006) included 14 species in this subgenus, and neglected to assign 14 other species to any subgenus. Among the species regarded as *Whartonia* (*Whartonia*), however, nine lack at least one of the aforementioned characters, most usually the tarsala III. These species are *W. delacruzi* Daniel & Stekol'nikov, 2002; *W. dewiti* Nadchatram, 1980; *W. diploctenum* Feider, 1983 (redescribed by Daniel and Stekol'nikov 2002); *W. diosi* Fain, 2002; *W. furcappa* Wen, Zhou & Jiang, 2001; *W. kulumadouensis* Goff, 1980; *W. multisetosa* Goff & Easton, 1991; *W. ratnasoorigai* Brown, Udagama-Randeniya & Seneviratne, 2003; and *W. teongwahi* Nadchatram, 1980. On the other hand, among the species not assigned to any subgenus, *W. glenni* (Brennan, 1962); *W. hainana* Mo, 1969, *W. longispina* (Radford, 1954); *W. perplexa* (Brennan, 1947); *W. scarcella* Vercammen-Grandjean, 1963; and *W. vellae* (Dumbleton, 1947) share those characters and hence must be included in the subgenus. A tabular key for the remaining 11 species is presented below (Table 1).

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Table 1: Table differentiating the characters of the species of *Whartonia* (*Whartonia*). *= Hosts of *W. nudosetosa*: *Artibeus jamaicensis yucatanicus*, *Peropteryx viacrotis*, *Balantiopteryx plicata*, *Carollia perspicillata*, *Carollia subrufa*, *Desmodus rotundus*, *Glossophaga soricina*, *Lasiurus borealis*, *Mimon cuzumelae*, *Pteropteryx macrotis*.

Species	Chaeotaxy coxa I, II and III	Genualae I, II	Subterminala, Parasub. I	Tibialae I, II, III	Chaeotaxy of palp	Formula of palpal tarsus	Galeala	Scutum setae formula	Host (all from the order Chiroptera)	Reference
angulascuta Reed & Brennan, 1975	2,1,2	2, 3–4, 7–11	1, 1 absent	variable	B, B, BBB	7B	branched	PL> AM> AL	*Carollia perspicillata, C. brevicauda, Chrotopterus auritus, Diphylla ecaudata*	Reed and Brennan, 1975
glenni (Brennan, 1962)	2, 1, 1	2, 1, 1	1, 1B	2,2,1	B, B, BBB	6B	branched	AM> AL=PL	*Balantiopteryx plicata, Macrotus californicus, Choeronycteris mexicana, Corynorhinus mexicanus*	Brennan, 1962; Vercammen-Grandjean et. al. 1965; Whitaker and Morales-Malacara, 2005
hainana Mo, 1969	2,1,1	3, 1, 0	1,-	2, 2, - (NM)	B, B, BNN	5B	nude	PL> AM> AL	*Rhinolophus affinis*	Mo, 1969
longispina (Radford, 1954)	2,1,1	2, 1, 1	1,1N	2,2,1	B, B, BNN	6B	branched	PL> AM> AL	*Rhinolophus clivosus acrotis*	Radford, 1954; Vercammen-Grandjean et al. 1965
novemsetosa Goff, 1982	2,1,1	2, 1, 1	1, 1N	2,2,1	N, N, BNN	7B	nude	PL> AM> AL	*Rousettus aegyptiacus*	Goff, 1982
nudosetosa (Wharton, 1938)	2,1,2	2,1,1	1,1B	2,2,1	B,N,B(N-B)(N-B)	7B	nude or sparsely branched	PL> AM> AL	*	Whitaker and Morales-Malacara, 2005
pachywhartoni Vercammen-Grandjean, 1966	2,1,2	2, 1, 1	1, 1B	2,2,1	B, B, BBB	7B	branched	AM> PL> AL	*Micronycteris megalotis/ C. perspicillata*	Vercammen-Grandjean, 1966 This study
penthetor Womersley, 1957	2,1,1	2, 1, 1	1, 1N	2,2,1	B, B, BNN	7B	nude	AM=PL>AL	*Cynopterus (Penthetor) lucasi*	Womersley, 1957
perplexa (Brennan, 1947)	2, 1, 1	NM	NM	NM	B, B, BBB	6B	branched	PL> AL> AM	*Eptesicus fuscus pallidus*	Brennan, 1947
scarcella Vercammen-Grandjean, 1963	NM	2, 1, 1	1,1N	2,2,0	B ,B, BBB	6B	branched	AM> PL> AL	*Rhinolophus hipposideros midas*	Vercammen-Grandjean,1963
vellae (Dumbleton, 1947)	2, 1, 1	NM	NM	NM	NM	NM	nude	PL> AM> AL	Not determined	Dumbleton, 1947

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